

**Model RS11 v2.0**  
**CANbus Engine Data Converter**  
NoLand Engineering, Inc.

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## 1. Introduction

The RS11 Engine Data Converter converts tachometer pulses and analog gauge voltages from virtually any engine into CANbus digital messages (J-1939 and NMEA 2000 protocols). It is configurable for either single or dual engine installations. The user must configure the RS11 for the desired data and calibration parameters such as pulses/rev, analog scale factors, etc. Configuration is performed via a Serial (RS-232) PC interface which also serves as an output data monitor, if desired. Output messages are applied to the CANbus, which can then be viewed by any appropriate display device. Power for the RS11 is supplied by the CANbus.

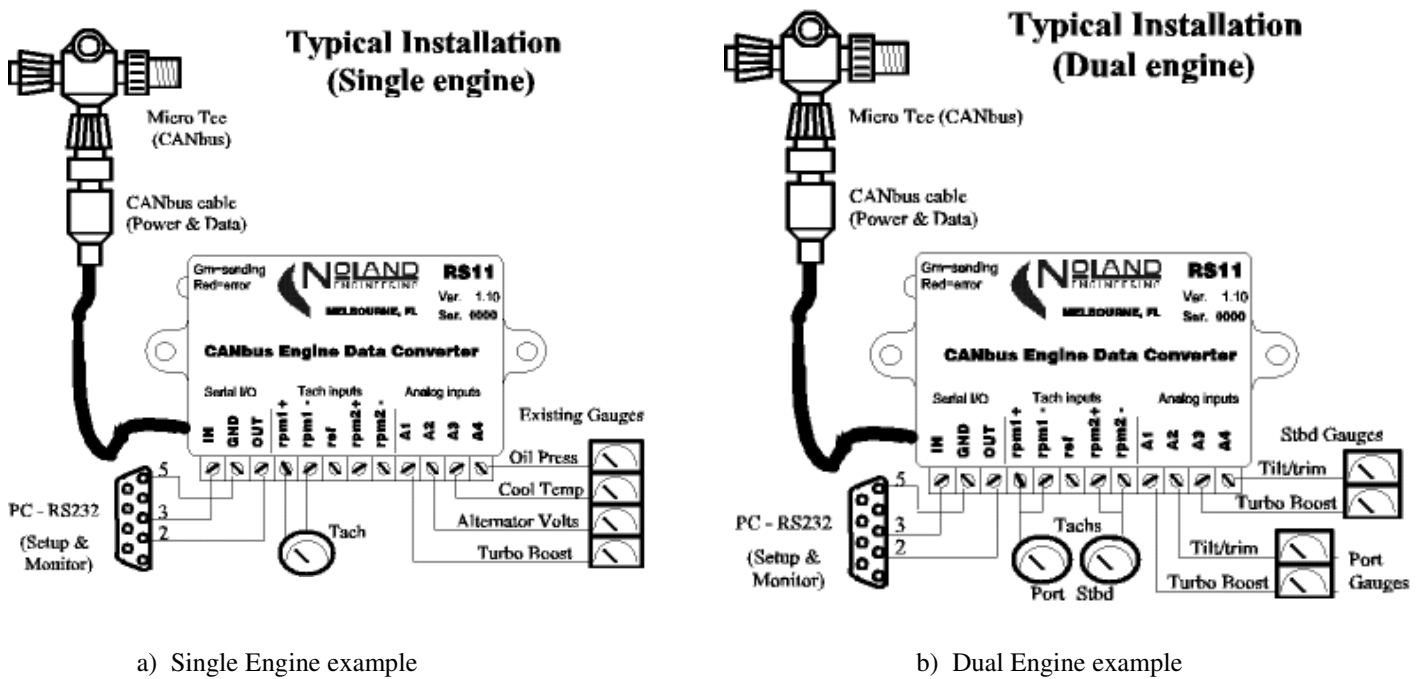
## 2. General

The RS11 is designed for versatile interfacing to almost any type of analog engine sensor or gauge commonly used on marine or automotive engines. It has two RPM (tach) inputs, four analog (gauge) inputs and supports both 12 and 24 volt systems. The analog inputs can be assigned all to one engine or be split between two engines. Multiple RS11's can be installed on the same CANbus.

The RS11 should generally be used in conjunction with existing analog gauges rather than as a replacement for them. This is because most sensors are “energized” by the existing engine gauges. The RS11 is designed to “piggyback” onto these gauges rather than replace them. In that sense the RS11 inputs are ‘passive’ so that they read sensor or gauge voltages, but do not provide power to the sensors.

The RS11 supports engine messages most commonly used by marine and industrial CANbus systems. As such, the user must perform an initial configuration of the unit to suit the particular engine(s). This consists of selecting the specific information to be sent and entering proper calibration factors. Configuration is done through a PC Serial interface and a special Setup Utility (see Appendix D) provided with the unit.

Typical installations for a single and dual engine are shown in Figure 1. For the single engine case, one RPM input is not used, and all analog inputs are available for that engine. In the dual engine case, the analog inputs must be divided between the two engines. This usually means each engine only gets two analog inputs. To get four analog inputs to each of two engines, you can use two RS11's, one for each engine. In this case, one of the RS11's must be set for Port Instance and the other for Starboard Instance.



**Figure 1. RS11 Installation Examples**

Interfaces

All engine sensor and/or gauge connections are made to a terminal strip on the RS11. CANbus connection is via the 5-pin “Micro-C” connector. A 9-pin PC cable is supplied for configuring the RS11, but may be left in place for data monitoring (via PC) if desired. The four analog inputs (A1-A4) can accept voltages up to 30Vdc. Analog sensor full-scale voltage ranges are jumper selectable by removing the case top. Tach inputs are often AC (alternator) or pulsed (ignition) signals, or they may be low voltage differential (2-wire) signals, such as inductive pickups. Table 1. summarizes the RS11 interfaces.

**Table 1. Interface Description**

IN, GND, OUT	Serial interface to PC. Used for configuration and data monitoring
rpm1+ , rpm1 -	Engine tachometer (Port or Single) input
ref	2.5V reference signal (used for some tach connections)
rpm2+ , rpm2 -	Engine tachometer (Stbd) input
A1 - A4	Analog inputs, selectable ranges (5V, 10V, 15V, 20V, 30V)
CANbus (cable)	CANbus ‘Micro C’ connector. Provides power/data interface.

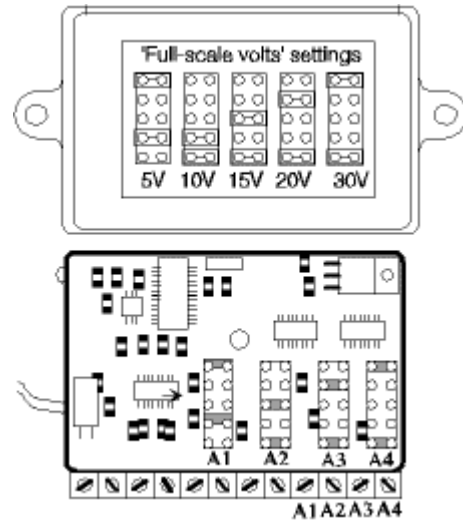
Analog Gauge/Sensor inputs

The RS11 analog-to-digital converters operate from 0-5V where 0V is referenced to the GND terminal. To measure higher voltage levels, jumper selectable voltage dividers are provided within the unit. Removing the RS11 cover exposes these jumpers (see Figure 2). Inside the cover is a diagram showing the jumper positions for each voltage range, up to 30V maximum. The analog inputs are high impedance so as not load your gauge or sensor.

### RPM (Tach) Connection

The RS11 is designed to support the most commonly used type of Tachometer sensors. Some sensors, such as inductive pickups, produce low level differential signals which the RS11 detects directly with its sensitive differential inputs. For other signals, such as ignition pulses or alternator tach outputs, the RS11 has a 2.5V reference signal ('ref') which is used as a stable threshold for detecting these often noisy signals.

In general, 2-wire tach signals (where one wire is NOT 'Ground') use both the "rpm+/rpm-" inputs directly. Single wire tach signals, such as ignition pulses or some alternator tach outputs, connect only to the "rpm+" terminal and have the "rpm-" terminal connected to "ref". The RS11 "rpm\_+/-" inputs are very high impedance so they do not load the tach signal. Connecting either of the "rpm-" terminals to "GND" will usually result in erroneous RPM readings or no RPM at all. The next section (INSTALLATION: Tach Hookup) contains more details regarding tach hookup and calibration.



**Figure 2. Analog full-scale voltage settings**

### CANbus Interface

The CANbus connector (Micro 'C') provides both DC power and the data interface to the RS11. Normally it is connected to an active network through a Tee. The RS11 has no other means of obtaining power besides this connector. If required, you can bench power the RS11 with a CANbus DC injector cable, which is useful for configuration, reprogramming etc. Sending messages, however, will only occur if it is connected to an active bus. The RS11 flashes a green LED whenever it sends messages and a red LED if errors or received messages occur.

### Serial (PC) Interface

The Serial Interface is intended for direct connection to a PC COM Port. It has several important functions, which include:

1. Configuration setup (RPM divider, Analog scale factors, data selection, etc.)
2. Monitoring data output and diagnosing errors on a PC.
3. Reprogramming and Software upgrades.

If your PC has no Serial interface, you can connect this to a USB-Serial adapter and perform all operations through the resulting Virtual COM Port. Although some configuration can be done manually, it is much better to use the supplied Setup Utility (see Appendix D). Error diagnosis should only be necessary if the red LED is seen flashing and improper operation is observed.

## **3. Installation**

Installation of the RS11 requires a CANbus (or another CANbus instrument) and access to your engine gauges or sensors. A PC with a Serial (COM) Port is also needed for initial configuration and calibration. If your PC has no Serial Port, you will need a USB-Serial adapter which provides a "Virtual COM Port".

### CANbus connection

A CANbus interface provides both power and data to/from the RS11. The unit will not operate without DC power from the bus interface. Connection to the bus is generally made with a 'Tee' from the main bus backbone. Once connected, the unit will immediately claim its address and begin sending messages to the bus, if enabled.

When connecting the RS11 to other CANbus instruments, a 120 ohm termination is usually needed somewhere on the bus. For small networks that only have a few devices and relatively short cable lengths, a single termination is adequate. For buses with many instruments and or very long cable lengths, it is better to place a termination at or near each end of the bus. Avoid assembling long buses with lots of multi-branching nodes. Instead, try to assemble a single backbone with each device directly connected to it using a Tee. Put a termination (120 ohm) somewhere along the backbone, and if it very long, use two terminations, one at each end.

### Serial Connection

A serial 9-pin connector is provided with each RS11 for connection to a PC. It is primarily intended for configuration of the unit, but may be left in place for data monitoring, if desired. If your PC has no Serial Port, a USB-Serial adapter will be needed. The Serial Interface will not function unless the RS11 is connected to either a powered bus or a Power Injection cable.

If you do not wish to leave the Serial cable connected, put it safely away for future use. If you ever need to reconfigure the RS11 or update its software, you will need this, or a similar, cable.

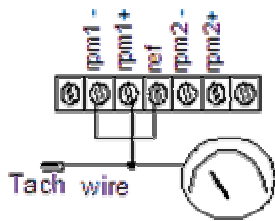
### Analog Gauge connections

Connections to the analog inputs (A1-A4) are usually made at the “sense” or ‘S’ terminals of existing gauges. Alternatively, the connections can be made directly at the engine sensor(s), if preferred. Keep in mind that the RS11 does not provide DC power to sensors, since that is normally done by the vessel gauges.

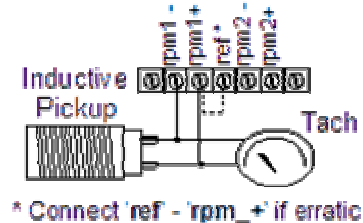
All analog inputs (A1-A4) must have their appropriate full-scale voltage set by jumpers within the unit. Figure 2 shows the 5 full-scale settings available. The specific jumper settings of each analog input depend entirely on what each input is measuring. For example, if an analog input is measuring the voltage of a 12 volt marine battery, the full-scale voltage should be set to 15V. For measuring a 24 volt battery, the full-scale voltage should be set to 30V. All jumpers are factory set to 15V and may be left this way for most 12V systems. For 24V systems, you may need to use the 20V or 30V setting. Sensors which produce only a few volts of maximum output should use the 5V setting.

### Tach hookup

There are several RPM (tach) connection alternatives. Most gasoline engines derive their tach signal from ignition pulses where a fixed number of pulses represent one revolution of the engine. The signal is often available on the back of the Tachometer, or a wire from an Engine Control Unit (ECU), or it can be obtained directly from the Ignition Coil. For these types of engines, the tach signal should be connected to RS11 ‘rpm 1(2)+’ terminal and the ‘rpm1(2) -’ terminal is connected to ‘ref’. Port side or single engine installations should use ‘rpm1+/-’ while starboard side engines should use ‘rpm2+/-’ (see Figure 3a). The ‘ref’ terminal is a stable 2.5V signal, which acts as a switching threshold for tach pulses. Most gasoline engine tach signals and alternator tach outputs will require the connection “ref” into the “rpm1(2) -” terminal(s). This hookup makes the RS11 more immune to noise on the Tach signal.



a) Ignition or Alternator Tach Hookup



b) Inductive Pickup Tach Hookup (diesel)

**Figure 3. RS11 Typical Tach Connections**

Diesel engines use another scheme for RPM sensing since they have no ignition system. Some diesels use an inductive pickup sensor at the flywheel, while others use a special output from the alternator. For the flywheel sensor, the number of teeth on the flywheel must be known, whereas alternator measured RPM requires knowledge of the number poles in the alternator and the alternator/engine pulley ratio. Alternator sensed RPM is most often connected as shown in Figure 3a.

Engines using an inductive pickup require the connection in Figure 3b. The “ref” connection to rpm1(2)+ terminal may not be needed unless there is no tach gauge present. Try connecting “rpm\_+” to “ref” only if erratic readings exist without it being connected.

Regardless of the type of tach connection, you must determine the ‘pulses/revolution’ (ppr) of the engine. The only simple case is with ignition-sensed gasoline engines. The number of pulses per revolution (ppr) is usually one-half the number of cylinders. So most 8-cylinder engines would have a ppr of ‘4’.

If the engine is a diesel with an inductive pickup at the starter flywheel, the ppr is equal to the number of teeth on the flywheel. Since few people actually know this number, you could start with a value of '126' and then go up or down as necessary until the correct RPM is obtained.

If you have an alternator sensed tach signal, you have the toughest problem of all, since the ppr depends on the number of poles in the alternator and the pulley diameter ratio between engine and alternator. The ppr value for this case is probably between '12' and '36', so pick a number, enter it into the RS11, and start testing.

### Configuration Setup

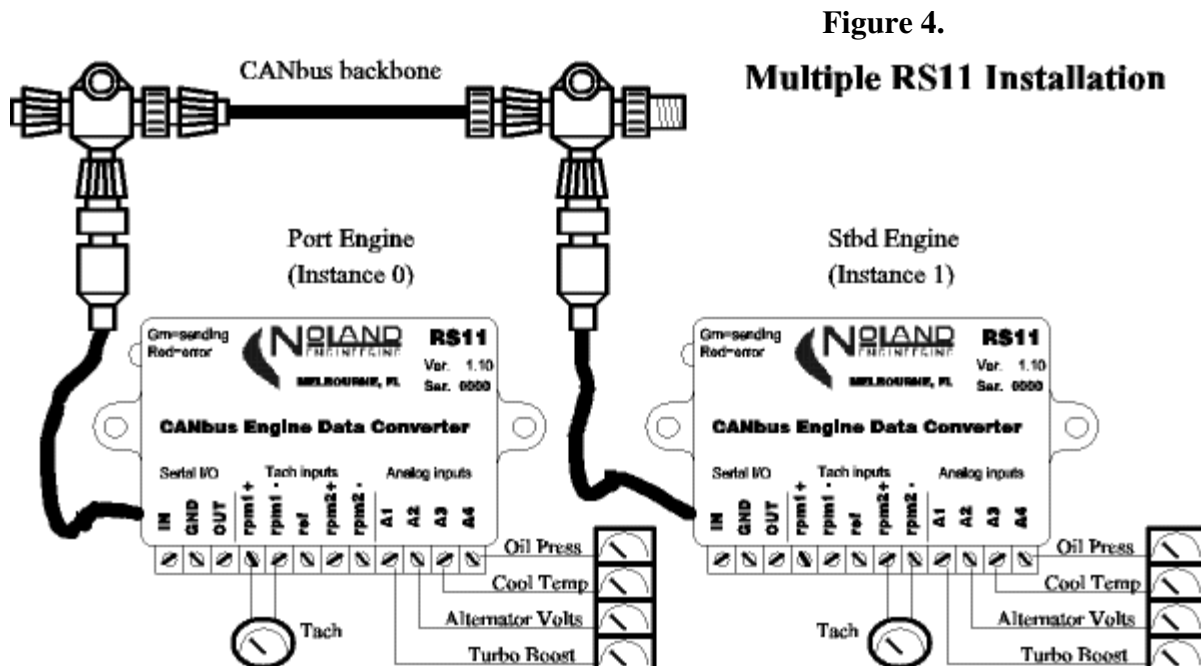
The RS11 must be properly configured before it will send any useful data. The following preparation should be done before configuration:

1. Decide which data you want to send (See Appendix A for help).
2. If RPM data is desired, determine engine pulses/rev (ppr).
3. For analog inputs, obtain 2 calibration points for each gauge/sensor.
4. Determine each analog "full-scale volts" range and set the internal jumpers.
5. Obtain a PC with Serial Port or USB-Serial Adapter.

If you can't do everything above, you can still configure the RS11 as much as possible and finish or update the configuration later. Examples of calibrating analog sensors is given in Appendix C. A PC Setup Utility is available to simplify the RS11 configuration (see Appendix D).

### Multiple RS11's

Installing multiple RS11's is particularly useful if you want more analog inputs than a single RS11 can provide. Each RS11 will have to be configured with a unique Instance id. An example is shown in Figure 4, where one RS11 is used for the Port engine and a second RS11 is used for the Starboard engine. Each RS11 must have a unique Instance id, which can be assigned during configuration. In this case, the Port side RS11 would have Instance id='0' and the starboard side RS11 would have Instance id='1'. Also, each RS11 must be configured as if it is only connected to a single engine (see Appendix B).



## 4. Operation

Once configured and calibrated, the RS11 operates autonomously with no intervention required. Appendix B and Appendix C contain details regarding configuration and calibration. A green flashing LED indicates the unit is sending data, while a red flash indicates received messages or errors.

### Output Data Monitoring

CANbus data is virtually impossible to view without special display units. Therefore the RS11 provides some simple data sentences in NMEA 0183 format, which can be viewed in any Terminal window. This data may prove useful in initially configuring the RS11, but it may also be used to separately monitor the RS11 data being applied to the CANbus.

To monitor the RS11 via its Serial Port, connect the PC serial cable per Figure 1. The RS11 must also be connected to a CANbus network before it will start sending data. With a Terminal window open and the PC connected to the RS11 COM\_Port at 4800 baud, text sentences should appear in the window. The RS11 Setup Utility contains such a viewing window.

The sentences beginning with

**\$ERRPM, , 0, x x x x, ,**

contain the calculated RPM value for each configured engine instance. The sentence contains both the Instance ID (usually '0' or '1') and the RPM value (shown as x x x x). If the RPM seems wrong it may be due to the wrong "ppr" value in the RS11. See Appendix B for instructions on changing the RPM ppr value(s).

The sentences beginning with

**\$PNOLA, x x . x, x x . x, x x . x, x x . x,  
A1 , A2 , A3 , A4**

contain raw values measured at the analog inputs, A1-A4 in that order. The values read as "% of full-scale" from 0.0 - 99.9, where the full-scale value is set by the analog input jumpers within the RS11. When you are configuring the RS11, you can actually use this data instead of a voltmeter. Simply multiply the value(s) above by the full-scale jumper setting of that input and you have the measured voltage.

Finally, if errors occur, a sentence beginning with

**\$PNOLE,..**

will be seen, which contains error codes. These codes are deciphered in the next Section (Troubleshooting).

### Reset

The RS11 must be reset before any configuration changes take effect. This can be done using commands through the Serial Port or removing DC (CANbus) power momentarily.

### Troubleshooting

Error codes (TDB)

## 5. Technical Specifications

RPM accuracy	+/-1 (ppr=200), +/-4 (ppr=60), +/-16 (ppr=12)
Tach input impedance	> 100 Kohm
Analog input accuracy	+/-0.2%(5V), +/-2%(10V, 15V, 20V), +/-4%(30V)
Analog input impedance	>10K(5V), >2K(10V), >3K(15V), >4K(20V), >6K(30V)
Serial data rate, format	4800 baud, NMEA 0183
Power	8-30 Vdc, 50ma. max
Temperature	0-50 degC
Humidity	0-100% (non-condensing)
Size, weight	2.2" x 3.5" x 1.0", 4 oz.

## 6. Warranty

Subject to the terms, conditions and limitations herein, NoLand Engineering warrants this product against manufacturing and material defects for a period of 24 months from the date of purchase. NoLand Engineering, at its discretion, will repair or replace the defective unit with new or refurbished parts. There is no other express warranty or representation of any kind that we make concerning this product.

It is the customer's responsibility to return the product safely to NoLand Engineering. Unless other arrangements are made, the customer must properly pack, ship, and insure the unit for return. If proof of purchase is not provided by the customer, NoLand Engineering will use its own records to determine the date of purchase.

Such repair or replacement is the sole remedy to the customer, consistent with local and provincial laws. Any repaired or replaced unit will be warrantied for the balance of the original product's warranty period.

This Limited Warranty does not cover the following:

- products with alterations to the serial number, mutilated labels, or missing labels
- failure from abuse, misuse, accident, over-voltage, unauthorized repair or modification, or improper installation.
- costs incurred from re-installation and testing

This Warranty gives you specific legal rights, and you may have other rights, which vary from state to state.

**APPENDIX A**  
**CANbus Messages**

CANbus networks such as J-1939 and NMEA 2000 send data in frames called 'messages'. Each message frame, or packet, transmits a maximum of 8 data bytes, so longer messages require multiple packets. The message packets contain the message ID along with the source and sometimes a destination addresses. The standard data rate is 250 Kbps.

J-1939 and NMEA 2000 protocols are similar because they are both derived from a parent Standard known as ISO 11783. The ISO standard defines important protocol parameters such as data rates, address claiming, message id formats, etc. For this reason J-1939, NMEA 2000, and ISO 11783 can share the same bus. The main difference between them is the specific messages utilized by each protocol. NMEA 2000 messages are geared toward marine navigation applications, while J-1939 is intended for large trucks and buses. The 3 standards also have different schemes for multi-packet messages. These protocols can operate together on the same bus, but they may not understand each others' messages.

Each CANbus message is identified by a Parameter Group Number (PGN), which is embedded in the message frame. The PGN specifically identifies the contents of each message. The table below lists the PGN's supported by the RS11. PGN's below 65535 may be used by all 3 protocols, whereas those above belong strictly to NMEA 2000.

**Table A1 RS11 Messages**

PGN	Tx	Rx	DESCRIPTION	MESSAGE DATA
59392			Acknowledgement	
59904		x	Request	
60928	x	x	Address Claim	Address and Name of device
126464	x		PGN List	List of Transmitted/Received PGN's by device.
126996	x		Product Information	Model id, Serial#, etc.
127488	x		Engine Parameters Rapid Update	RPM, Turbo Boost, Tilt/trim
127489	x		Engine Parameters Dynamic	Oil Press., Eng. Temp., Batt. Volts, Oil Temp., etc.

Engine Parameters Rapid Update

This short (single packet) message is sent 4 times/second for each engine. It contains RPM, Turbo Boost Pressure, and Tilt/trim indication. Separate messages are sent for Port and Starboard engines with each side using a unique "Instance ID". Instance ID = 0 is used for Port or Single engine, while Instance ID=1 is for Starboard engine.

Engine Parameters Dynamic

This multi-packet message contains most of the important engine sensor information, which does not require fast updating. It is sent once/second for each engine. The following data fields are contained in this message:

**Oil Pressure**  
**Oil Temperature**  
**Engine (Coolant) Temperature**  
**Alternator volts**  
Fuel Rate  
Engine Hours  
**Coolant Pressure**  
**Fuel Pressure**  
Status1  
Status2  
%Load  
%Torque

any of the items above in bold can be assigned to any available Analog Input (A1-A4) of the RS11. For example, if the RS11 is monitoring a single engine and all 4 analog inputs are available, they could be assigned to the top 4 items in the above list. If, however, two engines are being supported with one RS11, you would have to divide up the available Analog Inputs (A1-A4) between your two engines.

**APPENDIX B**  
**Programming Instructions**

**Introduction** : The RS11 is capable of accepting certain commands and taking appropriate action such as a device reset. The commands are also used to configure various options, such as message selection. All programming is done through A Serial (RS-232) PC interface.

Although programming can be done directly through a Terminal Window, it is much easier to configure with the Setup Utility supplied with the RS11. You can download this utility from our website, if needed. If, however, this utility is not available or you only need to make some simple configuration changes, the following instructions and examples will prove helpful.

Commands typed into a Terminal window are sent to the RS11, which will check their validity and take appropriate action. All commands begin with an “@” character followed by another character which defines the action to take. Some actions will need additional characters (options) to more specifically define the action. A list of command characters and options is given in Table B-1.

**Table B1 RS11 Commands**

Command	Action	Options	Comments
<	Stop device	(n/a)	Stop data for programming
>	Reset (restart) device	(n/a)	Same as power disconnect-reconnect
?	Help / Query configuration	(n/a)	Shows help / Shows current device configuration
I or i	Set Instance ID, Port/Stbd	0 - 9	<b>Port = 0, 2, 4, 6, 8 / Stbd =1, 3, 5, 7, 9</b>
P or p	Port pulses per revolution (ppr)	<b>000</b> – 250	Leading zeroes required ('000' = not used)
S or s	Stbd pulses per revolution (ppr)	<b>000</b> – 250	Leading zeroes required ('000' = not used)
N or n	Enable CANbus message	1- 4, +/-	<b>1/2, +/- =Port,Stbd Eng Param Rapid U/D, on/off</b> 3/4, +/- = Port,Stbd Eng Param Dynamic, on/ off
R or r	Analog assign, (Eng Rapid Update)	1- 4, +/-	1/3, +/- = Port/Stbd Turbo Boost, on/off 2/4, +/- = Port/Stbd Tilt-trim, on/off
D or d	Analog assign, (Eng Param Dynamic)	1-4, P/S/-, 1-6	Assigns A1-A4 to Port/Stbd fields 1-6 of Engine Parameters Dynamic message
X or x	Analog X_value	+/- <b>0-9999</b>	Use special Setup Utility to calculate this value
Y or y	Analog Y_value	+/- <b>1-125</b>	Use special Setup Utility to calculate this value
Z or z	Analog Z_value	<b>0-9</b> +/-	Use special Setup Utility to calculate this value

Some of the above commands are simple and straightforward. Others may seem quite confusing, and we recommend only using them when necessary or convenient. Instead, we provide a PC Setup Utility, which simplifies configuration of the RS11 and eliminates the need for executing any of these commands. There may, however, be some situations where it is easier to make simple updates using above commands rather than the supplied Utility.

## Programming Example

An example will demonstrate how to configure the RS11. Connect the Unit to a powered CANbus or power injection adapter. Also connect the device to a PC using the supplied 9-pin Serial Cable. If necessary, a USB-Serial Adapter (not included) may be used. On the PC, open a Terminal window and set it to match the following:

Baud rate	4800
Data bits	8
Stop bits	1
Parity	None
Flow Control	None

The Terminal program should be set to send characters as soon as typed. You should not need to hit 'ENTER' to send the command. You are now ready to send a command. If the device is currently receiving data, you can stop the data flow by typing

@<

This causes the data flow to stop. If not, your command was either not sent or it was typed incorrectly. You may need to change your Terminal Program settings. If you now type

@?

You will get a list of the current configuration settings as well as a list of commands/options.

### Instance setup

Assume we now want to change an Instance ID. By typing

@I2 or @i2 and @I3 or @i3

the Port or Stbd Instances id would change to 2 and 3 respectively. Note that both lower and uppercase commands are valid. To confirm the change, type another '@?' and look for the Instance ID's at the end of "CAN1 .., CAN2 .." lines as shown below.

```
RS11 v1.65 [9876] Current Configuration: [2/3]
Msg1/2 Port/Stbd Rapid ID (ON)/(ON) [ppr=060/060]
Msg3/4 Port/Stbd Dynamic (OFF)/(ON)
Msg5/6 Port/Stbd Fuel (OFF)/(OFF)
Msg7/8 Port/Stbd Trans (OFF)/(OFF)
A1 = Port Rapid ID-Boost Pres [X,Y,Z = -2681, +045, 2, (ON)]
A2 = Port Rapid ID-Tilt/Trim [X,Y,Z = +4021, -022, 0, (ON)]
A3 = Stbd Dynamic -Oil Temp [X,Y,Z = +3809, -029, 4, (ON)]
A4 = Stbd Dynamic -Batt Volts [X,Y,Z = +0000, +047, 5, (ON)]
```

It will remain configured this way unless it is reconfigured sometime in the future. To verify the configuration change was accepted, we can again type "@?" which will show

### RPM setup

To calibrate RPM, you must have the RPM message enabled. This can be done with the command

@P \_\_\_ or @p \_\_\_ (Port RPM),  
@S \_\_\_ or @s \_\_\_ (Stbd RPM)

where the 3 dashes represent the ppr value for your engine(s). Assuming we have a V8 engine with a tach signal derived from Ignition Coil pulses, the ppr will likely be 4 so the command is

@P004 or @p004

for the Port (or single) Engine. The same command with the 'P' replaced by 'S' or 's' will set the Starboard Engine ppr. If you do not know the engines' ppr, you can keep entering different values and resetting the unit by typing

@ >

This restarts the unit with your new settings. You can view the "\$ERRPM,.." sentence in your Terminal window to see if the RPM is reading correctly. This trial-and-error procedure may be needed for most diesel engines with alternator tach signals or flywheel inductive pickups. To turn off Port or Stbd RPM enter a ppr value of '000'.

### Message Selection

To select which message(s) the RS11 sends, use the command:

**@N#+** or **@n#+**

where # is the number of the message desired. This version has 2 different messages, but they can be enabled for both engines (port, stbd) giving a maximum of 4 messages. The message # for each message and its on/off state can be seen near the top of the list when an "@?" command is sent. To turn off a particular message, use the command:

**@N#-** or **@n#-**

where '#' is the message number to be disabled. A more detailed description of the messages is in Appendix A.

### Analog setup

Each of the 4 Analog inputs (A1-A4) can be used in any of the four possible messages with certain limitations. The table below shows the Analog field assignment for just the Engine Parameters Rapid Update message. The field assignments in Table B2 cannot be changed; they can only be turned on or off.

**Table B2 Rapid Update Message data field assignments**

Command	Input	Input assigned to field ..
@R1+ or @r1+	A1	Port Turbo Boost (Instance 0)
@R2+ or @r2+	A2	Port Tilt/trim (Instance 0)
@R3+ or @r3+	A3	Stbd Turbo Boost (Instance 1)
@R4+ or @r4+	A4	Port Tilt/trim (Instance 1)

Sending any of the above commands with a "-" rather than a "+" sign will remove the assignment for input so that it can be used for another message field.

Any remaining Analog Inputs you do not use for the "Rapid Update" message(s) can be assigned to the Engine Parameters Dynamic message(s), if desired. The following commands assign analog inputs to the Engine Parameters Dynamic message:

**Table B3 Engine Parameters Dynamic Message data field assignments**

Command	Input	Input assigned to field ..
@D#P1 or @d#p1 @D#S1 or @d#s1	A#	Port Oil Pressure (Instance 0) Stbd Oil Pressure (Instance 1)
@D#P2 or @d#p2 @D#S2 or @d#s2	A#	Oil Temperature (Instance 0) Oil Temperature (Instance 1)
@D#P3 or @d#p3 @D#S3 or @d#s3	A#	Engine Temperature (Instance 0) Engine Temperature (Instance 1)
@D#P4 or @d#p4 @D#S4 or @d#s4	A#	Battery Volts (Instance 0) Battery Volts (Instance 1)
@D#P5 or @d#p5 @D#S5 or @d#s5	A#	Coolant pressure (Instance 0) Coolant pressure (Instance 1)
@D#P6 or @d#p6 @D#S6 or @d#s6	A#	Fuel Pressure (Instance 0) Fuel Pressure (Instance 1)

To remove any of the above assignments, send the command

**@D# - or @d# -**

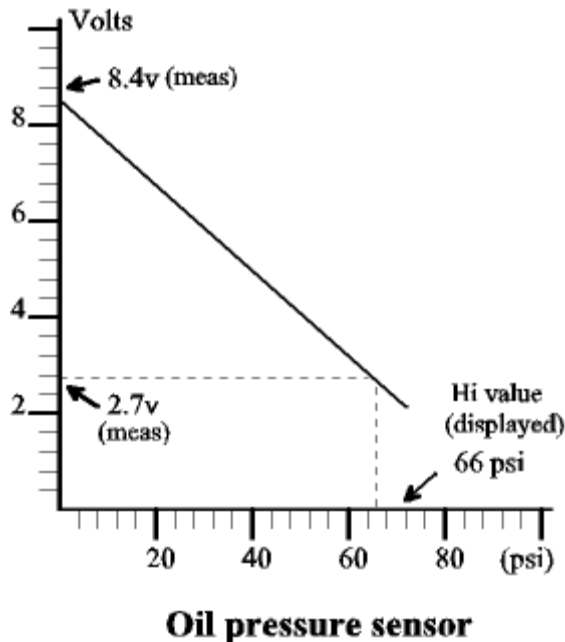
where '#' is the number of the Analog Input (1-4) to be removed from the message.

Use of most of the above commands is not recommended. The RS11 includes a PC Setup Utility which makes configuration much easier than using these commands.

## APPENDIX C

### Analog Gauge (sensor) Calibration Examples

This Section describes the relatively simple and straightforward method for calibrating analog gauges and sensors so that the RS11 can output the correct data. To use this method most effectively requires that you have the RS11 installed in the vessel, CANbus power available, and the engine gauges or sensors operational and connected to RS11 analog inputs (A1-A4). A voltmeter might also prove useful, but it is not essential since the RS11 analog inputs can function like a voltmeter. Shown below is an example of an engine oil pressure sensor characteristic. The voltage measured at the "S" (sense) terminal of the vessels' oil pressure gauge is shown in the graph. It is a negative slope characteristic, which is typical of these sensors. Most sensors exhibit an approximately linear (straight line) characteristic over their range of interest. The RS11 assumes this straight line characteristic for all sensors. Two points on the line are needed for each analog gauge or sensor. A voltmeter may be needed to determine these points, but the RS11 can be used as a voltmeter as described later.

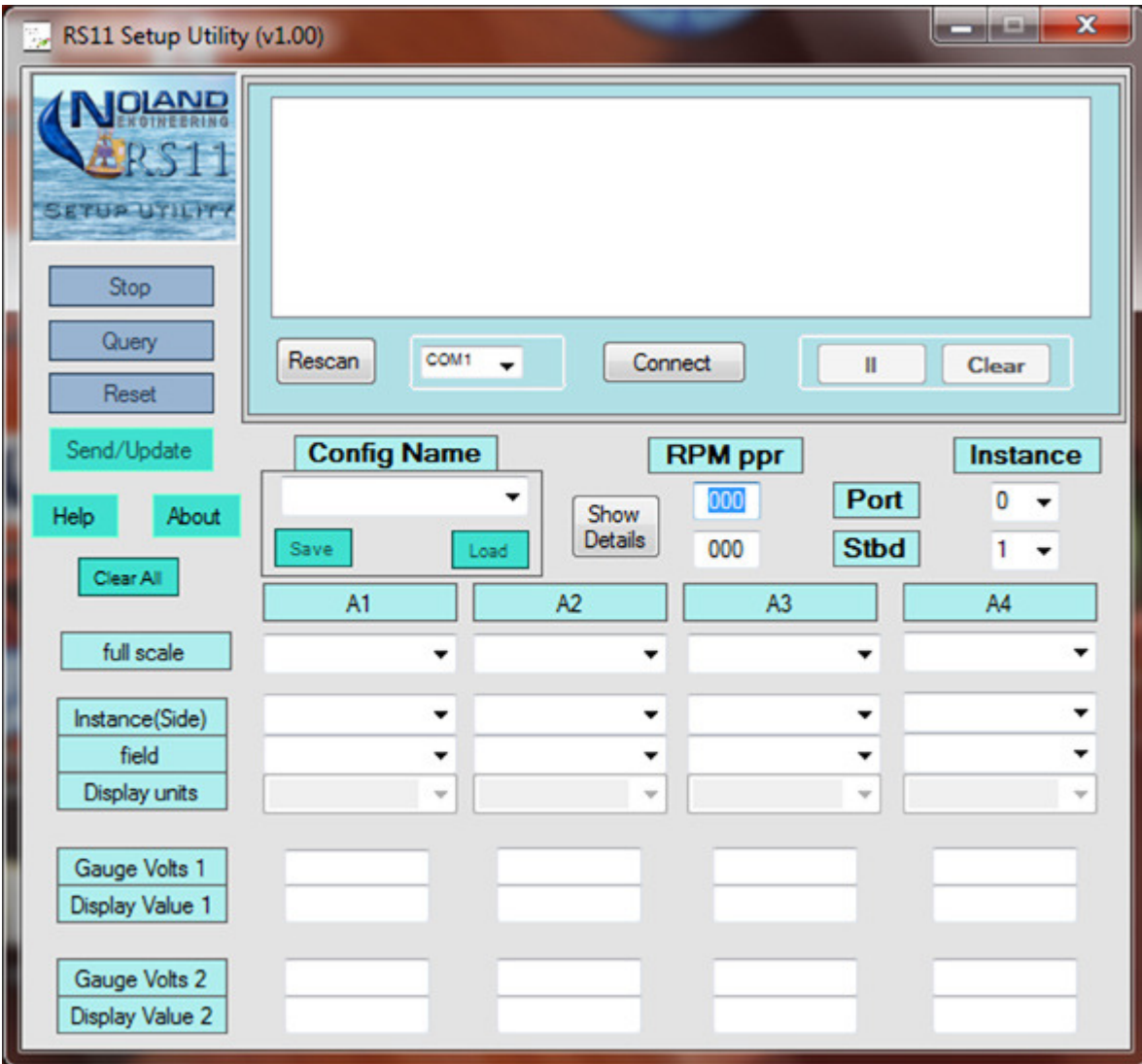


Our first point on the curve is usually easy to obtain. For the case of Oil Pressure, we know the pressure is '0' when the engine is not running, so all we need is the gauge voltage with engine 'off' but gauges switched 'on'. That reading is represented by the upper left point (8.4V) on the example graph above. Rather than use a voltmeter, we could instead read the "% f.s" volts measurement from the "\$PNOLA,... " sentence of the RS11 (see Section 4— Output Data Monitoring). If A1 is assigned to "Oil pressure" and the full-scale jumper setting in the RS11 is set to 10V, the reading would show "\$PNOLA,84.0,.." for the Oil Pressure analog input (A1 shown here). Note that  $10V \times 84\% = 8.4V$ , so in effect we are using the RS11 analog input as a voltmeter.

Next, with the engine running, assume the oil pressure increases to 66 psi and the gauge voltage now reads "2.7V" (or "\$PNOLA,27.0,.."). This is our second data point for calibrating this gauge/sensor. The other three gauges/sensors are calibrated the same way. The recorded data points for all gauges or sensors are then entered in to the Setup Utility, which will process and download calibration factors to the RS11.

## APPENDIX D RS11 Setup Utility

The RS11 Engine Data Converter converts tachometer pulses and analog gauge voltages from virtually any engine into CAN-bus digital messages compatible with J-1939 and NMEA 2000 protocols.



This utility will assist you in configuring the RS11 for the particular message(s) required and calibration parameters such as pulses/rev, analog scale factors, etc. Configuration data is sent to the RS11 via a Serial (RS-232) PC interface, which can also serve as an output data monitor, if desired.

The RS11 must be properly configured before it will send any meaningful data. The following preparation should be done before configuring the RS11:

1. Decide what data you want to send.
2. If RPM data is desired, determine engine pulses/rev (ppr).
3. For analog inputs, obtain 2 calibration points for each gauge/sensor.
4. Determine each analog “full-scale volts” range and set the internal jumpers. (factory set to (5V))
5. Obtain a PC with Serial Port or USB-Serial Adapter as needed.

If you can't do everything above, you can still configure the RS11 as much as possible and finish or update the configuration later.